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* NOTICES *

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2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] It is the ****-cross section of an example of the temperature sensor by this invention.
[Drawing 2] It is the plan showing an example of the arrangement on the substrate of a temperature sensor.
[Drawing 3] It is process drawing (the 1) of an example of this invention process.
[Drawing 4] It is process drawing (the 2) of an example of this invention process.
[Drawing 5] It is process drawing (the 3) of an example of this invention process.
[Drawing 6] It is a plan in one manufacturing process.
[Drawing 7] It is the block diagram showing an example of the temperature detection mode from a temperature sensor.
[Drawing 8] It is a ****-cross section in the process with which explanation of other examples of this invention method is presented.
[Drawing 9] It is a ****-cross section in the process with which explanation of other examples of this invention method is presented.
[Drawing 10] It is the manufacturing process view of other examples of this invention process.
[Drawing 11] It is the plan of the conventional temperature sensor.
[Drawing 12] It is the ****-cross section of the important section of the conventional temperature sensor.
[Description of Notations]
21 Substrate
22 Insulator Layer
23 1st Wiring
24 2nd Wiring
25 Bore
26 Metal Plug
30 Temperature Sensor

[Translation done.]

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Industrial Application] this invention relates to a temperature sensor.
[0002]
[Description of the Prior Art] In for example, the CVD (chemical vapor growth) equipment of the equipment used for manufacture of various semiconductor devices, for example, membrane formation equipment, or a sputtering system, an etching system, etc., the temperature control has big influence on the processing in each equipment.
[0003] In the usual CVD system etc., temperature sensors, such as two or more thermocouples, are prepared in the susceptor which lays the processed wafer, and it is made as [perform / the measurement or temperature surveillance]. However, the temperature distribution in the front face of the wafer in the case of carrying a wafer the temperature distribution on this installation base, i.e., a susceptor, and on this in practice, and processing the target CVD etc. do not correspond.
[0004] Especially in a CVD system, from the temperature control being performed correctly [when it is necessary to know correctly the temperature distribution in the processed substrate in the time of actual CVD processing, for example, Si semiconductor wafer front face, and especially new equipment is introduced into the production line] Or it is necessary to know beforehand the temperature distribution on Si semiconductor wafer actually arranged in these equipments, for example, a CVD system, in advance of the CVD system made into the purpose when grasping the temperature characteristic by aging in this equipment periodically also in the equipment already used.
[0005] Usually, as the plan is shown in drawing 11 and the cross section of the important section is shown in drawing 12 , this measurement The processed substrate which should perform CVD when using measurement of the temperature distribution as a line bowl in a CVD system For example, for example, the same material as Si wafer, It prepares, the substrate 1, i.e., for example, Si wafer, for measurement monitors which has a size configuration. It has necessary arrangement in the front face, and is aluminum 2O3 about two or more thermocouples 2. It attaches with cement. The method of measuring the temperature corresponding to the processed [arrange, for example in a CVD system, heat under the time of CVD processing and these conditions, and] wafer front face at the time of the CVD processing made into the purpose in this state is taken.
[0006] However, arranging such a thermocouple on a substrate 1 has restrictions in the number of arrangement, and the problem that the temperature distribution on the semiconductor wafer made into the purpose cannot be measured is also on a substrate with a sufficiently high precision.
[0007] Discharge of the impurity which furthermore affects the property to a semiconductor wafer by the heating at the time of this thermometry arises, and the inside of these CVD systems is soiled, and when original CVD processing is performed next, it causes un-arranging, such as generating of a defective -- the membraneous quality of the CVD film which the incorporation of an impurity was made and was obtained, and an electrical property become unstable -- and degradation of a property.
[0008]
[Problem(s) to be Solved by the Invention] In the CVD system accompanied by various heating or cooling which mentioned this invention above used for manufacture of a semiconductor device, for example The temperature on the processed object in this CVD system, for example, the front face of a semiconductor wafer, correctly Moreover, the temperature sensor which enables it to measure exact temperature distribution with dense point of measurement therefore, and can avoid fear, such as generating of the impurity to a semiconductor etc., further and its process of a large number on the wafer are offered.
[0009]
[Means for Solving the Problem] As the ****-cross section of the example is shown in drawing 1 , the 1st this invention is arranged so that it may counter in the bore 25 which drilled the 1st wiring 23 and the wiring 24 of the 2nd in the insulator layer 22 at least through the insulator layer 22 which consists of SiO2, SiN, etc.
[0010] And the metal plug 26 electrically connected to the 1st wiring 23 is formed in the bore 25 of an insulator layer 22, the electrostatic capacity by change of the gap g between this metal plug 26, and the metal plug 26 and the 2nd wiring 24 by the temperature based on a coefficient-of-thermal-expansion difference with an insulator layer 22, i.e., a gap, or generating of Gap g is detected, and a thermometry is performed.
[0011] As the ****-cross section of the example is shown in drawing 1 , the 2nd this invention is arranged so that it may counter in the bore 25 which drilled the 1st wiring 23 and the wiring 24 of the 2nd in the insulator layer 22 at least through the

insulator layer 22.
[0012] And the metal plug 26 electrically connected to the 1st wiring 23 is formed in the bore 25 of an insulator layer 22, the tunnel current by change of the gap g between the metal plug 26 and the 2nd wiring 24 by the temperature based on the coefficient-of-thermal-expansion difference of this metal plug 26 and insulator layer 22, i.e., a gap, or generating of Gap g is detected, and a thermometry is performed.
[0013] Moreover, in the 3rd this invention, as shown in drawing 2 , array formation of two or more temperature sensors 30 by above-mentioned composition is carried out on the common substrate 21, i.e., the substrate for monitors.
[0014] The 4th this invention forms the metal plug 26 in above-mentioned composition by CVD (chemical vapor growth).
[0015] The 5th this invention forms the metal plug 26 by the selective-growth method of the metal.
[0016] The 6th this invention makes the metal plug 26 produce a thermal contraction, and it is made for Gap g to produce it between this and the 2nd wiring 24.
[0017]
[Function] As compared with an insulating material, as compared with an insulator layer 22, the metal plug 26 uses cubical expansion or contracting remarkably, and a metaled coefficient of thermal expansion changes the gap g between this metal plug 26 and 2nd wiring 24 to high sensitivity, and carries out detection or measurement for change of this gap, i.e., change of temperature, as change of electrostatic capacity according to generally it being very large, i.e., a temperature change, in this invention. or the thing for which predetermined voltage is impressed between the 1st and 2nd wiring 23 and 24 -- generating of the tunnel current in Gap g, and its size -- the size of Gap g, therefore detection of temperature -- or it measures Therefore, differential can be carried out as a temperature sensor of high sensitivity.
[0018] If temperature rises as it mentioned above, when now seen about electrostatic capacity, the metal plug 26 will be compared with expanding remarkably, for example, it is SiO2. Or the insulator layer 22 which consists of SiN etc. hardly expands. Therefore, Gap g becomes small and electrostatic capacity increases it. When this electrostatic capacity that increases by the temperature change is seen, now the length of a metal plug Next, L0, The cross section of LT and a plug for the length of the metal plug 26 in the temperature to measure S, a dielectric constant [in / T0 and Gap g / gap length / in d0 and the temperature to measure / length / gap (gap) / in a room temperature / alpha and measurement temperature and / for a room temperature / in the coefficient of linear expansion of the composition metal of dT and the metal plug 26] -- epsilon 0 ** -- if it carries out, change of electrostatic capacity will be called for as follows / T Coefficient of linear expansion alpha is [Equation 1] here.

$$\alpha = \frac{1}{L_0} \cdot \frac{L_T - L_0}{T - T_0}$$

Since come out and it is, capacity variation deltaC is [Equation 2].

$$\Delta C = \frac{\varepsilon_0 S}{d_T} - \frac{\varepsilon_0 S}{d_0}$$

$$\sim \frac{-\varepsilon_0 S \Delta d}{d_0^2} \qquad (\Delta d = d_T - d_0)$$

$$= \frac{\varepsilon_0 S}{d_0^2} \alpha \cdot L_0 (T - T_0) \qquad (\Delta d = -(L_T - L_0))$$

It becomes. The variation of electrostatic capacity turns into an amount proportional to temperature from this formula.
[0019] And it is made to counter in this invention through the bore 25 which drilled the 1st and 2nd wiring 23 and 24 in the insulator layer 22 through the insulator layer 22, as mentioned above. The metal plug 26 electrically connected with one wiring 23 of the 1st is formed in the bore 25 of an insulator layer 22. From the ability of many temperature sensors 30 to be simultaneously formed with high density to the common monitor substrate 21, since change of electrostatic capacity or a tunnel current detected the temperature for the gap g between this and the 2nd wiring 24 changing with temperature changes The temperature distribution covering the whole region of a wafer can be measured correctly.
[0020]
[Example] With reference to drawing 1 , an example of the temperature sensor by this invention is shown. In this invention, the substrate 21 for monitors which makes good the same material as the substrate, for example, Si semiconductor wafer, which performs temperature detection, and which uses the CVD processing as a line bowl, for example in a CVD system, and a size configuration and which consists of an Si wafer, for example is prepared.
[0021] Form the 1st wiring 23 which consists of metal layers, such as AlSj, and Cu, W, aluminum, Ti, on this substrate 21, and the insulator layer 22 by which the bore 25 was drilled on this and to which it is thin from SiO2 of more than 10 or number +mum, SiN, etc., for example is minded. The 1st wiring 23 mentioned above on this and the 2nd wiring 24 which

consists of same various metals are formed as countered in wiring 23 and a part of the 1st through a bore 25 at least.
[0022] the inside of a bore 25 -- an insulator layer 22 -- comparing -- enough -- coefficient of thermal expansion -- size -- the metal plugs 26, such as a metal, for example, W and Cu, and AlSi, -- gap length dT necessary with a room temperature to between the 2nd wiring 24 It forms so that Gap g may be generated.
[0023] Thus, as the plan is shown in drawing 2 , on the common substrate 21, with the distribution of necessary arrangement, many temperature sensors 30 to constitute are illustration, for example, carry out array formation simultaneously 17 pieces.
[0024] And 1st wiring 23 is carried out in common, concerning each temperature sensor 30, the 2nd wiring 24 is formed in a necessary pattern, respectively, and it derives to a part of substrate 21.
[0025] An example of the temperature sensor by this invention is explained in detail with an example of the manufacture method with reference to drawing 3 - drawing 6 .
[0026] As shown in drawing 3 A, the 1st wiring 23 is formed on the substrate 21 for monitors, for example, Si wafer. This 1st wiring 23 forms AlSi of Si3% content for example, by the whole surface spatter, for example, is based on a necessary pattern at a photolithography, and carries out selection-etching.
[0027] It is SiN and SiO2 extensively [as shown in drawing 3 B] including the 1st wiring 23 top. The becoming insulator layer 22 is formed in the thickness of 11 micrometers by plasma CVD.
[0028] As shown in drawing 3 C, as opposed to an insulator layer 22, one side drills the bore 25 of 10-micrometer square pattern by reactive ion etching.
[0029] As shown in drawing 4 A, the metal layer 31, for example, AlSi, is extensively formed by the elevated-temperature spatter including the inside of this bore 25.
[0030] As shown in drawing 4 B, a microwave etching system is used as opposed to the metal layer 31, and it is BCl3. Cl2 Etchback is extensively performed using mixed gas and etching removal of the metal layers 31 other than bore 25 of an insulator layer 22 is carried out. In this case, in a bore 25, as the metal layer 31 is left behind with thickness smaller than the thickness of a bore 25, the metal plug 26 is formed by this.
[0031] As shown in drawing 4 C, the inside of the bore 25 on the metal plug 26 is embedded, and a filler 32 is applied extensively. For example, low-melting-glass ******** SOG (spin-on glass) which can **** this filler 32 easily by the etching reagent which is not dipped to the metal plug 26 or the 2nd wiring mentioned later, and can embed the inside of a bore 25 good is used.
[0032] As shown in drawing 5 A, an parallel monotonous plasma etching system is used for a filler 32, for example, SOG, and it is CHF3. Etching gas performs all-out etchback. This etchback is performed [in a bore 25] to the position where a filler 32 remains with necessary thickness on the metal plug 26.
[0033] As shown in drawing 5 B, the metal layer 33 is similarly formed in the thickness of 1 micrometer for AlSi of Si content extensively by the spatter etc. 3%.
[0034] As shown in drawing 5 C, alternative etching by the photolithography etc. is performed to the metal layer 33, and a necessary pattern and the 2nd wiring 24 with which the part counters with the 1st lower layer wiring 23 through the bore 25 of an insulator layer 22 especially are formed.
[0035] In this case, as the 2nd wiring 24 shows the plan to drawing 6 , the width of face is selected from the width of face of a bore 25 to smallness, and some fillers [at least] 32 are made not to be covered by the 2nd wiring 24. And it **** from the portion which exposed the filler 32 from the 2nd wiring 24 with the etching reagent, for example, BHF solution, which does not dip the metal plug 26 and the 2nd wiring 24.
[0036] In addition, although cover the 2nd wiring 24 and it is not illustrated if needed, the coat of the protective coat can be carried out.
[0037] If it does in this way, the gap g which the filler 32 was removed between the metal plug 26 and the 2nd wiring 24, and was produced as drawing 1 showed the cross section will be generated.
[0038] Thus, so that the part may counter [in / the bore 25 / in the 1st wiring 23 and the wiring 24 of the 2nd] at least through an insulator layer 22 on a substrate 21 Moreover, the temperature sensor 30 by this invention made into the purpose by which the metal plug 26 electrically connected to the 1st wiring 23 was formed in the bore 25, and the necessary gap g was further formed between this metal plug 26 and 2nd wiring 24 is constituted.
[0039] And as each wiring is electrically drawn [in / here / can arrange many temperature sensors 30 in parallel simultaneously with / as drawing 2 explained to the substrate 21 in this case / the same process, draw the wiring 24 of the wiring, for example, the 2nd, to the unilateral of a substrate 21, for example, the facet section and] outside with lead 41 through a connector 40 and it is shown in drawing 7 , it connects with a switcher, for example, a relay switch, respectively. The power supply track 43 is connected to this switcher 42, and it is supplied by the track 44, and by the electrostatic capacity or the tunnel current from each temperature sensor 30, a control signal and a data signal select a detecting signal one by one, and read it further, for example.
[0040] Moreover, in the method mentioned above, although it is the case where the metal layer 31 which the metal plug 26 forms is formed by the elevated-temperature spatter, the tungsten W which formed this by CVD can also constitute. That is, it is ****** to constitute the temperature sensor 30 which forms W metal layer 31 on this through the barrier layer 50 of TiN if needed so that the inside of a bore 25 may be embedded by CVD, for example, completely takes the same method with drawing 4 - drawing 6 having explained after that as forms membranes serially, and is shown by drawing 1 from the base and side attachment wall in a bore 25, as shown in drawing 8 .

[0041] Furthermore, as the selection CVD of W or Cu shows to drawing 9 as this metal plug 26 again, it can form.
[0042] For example, the selection CVD of W is WF6. SiO2 which constitutes an insulator layer 22 although it uses as material gas and this grows well as W layers by the reduction operation by this to Silicon Si or a metal Using receiving and hardly growing up, on an insulator layer 22, membrane formation does not arise and the metal plug by W can be alternatively formed only in the bore 25.
[0043] Moreover, it sets, when forming this metal plug 26 by the selection CVD of Cu, and it is Cu (HFA)2 / H2, for example as material gas. It can mix and send into 2/100sccm, and can form with 300 degrees C and the pressure of 2000Pa.
[0044] Moreover, in this invention, the method of forming the gap g between the metal plug 26 and the 2nd wiring 24 by the metaled thermal contraction can be taken.
[0045] An example in this case is explained with reference to drawing 10 . In drawing 10 , the same sign is given to the portion corresponding to drawing 3 - drawing 5 , and duplication explanation is omitted.
[0046] Also in this case, as shown in drawing 10 A, the same method is taken with drawing 3 A - drawing 3 C having explained, and a bore 25 is drilled in an insulator layer 22.
[0047] And the metal plug 26 of Cu is formed in a bore 25 by the same selection CVD of Cu with having mentioned above in this bore 25.
[0048] Then, it is temperature higher than the temperature requirement which performs temperature detection an elevated temperature, i.e., finally, and is made for the metal plug 26 of Cu to be in the state of forming the same flat surface mostly with the front face of an insulator layer 22, exactly, for example in the state where it heated with the low, for example, 900 degrees C, from the heat-resistant temperature to the monitor substrate 21. That is, the thickness of Cu selection membrane formation of the metal plug 26 is decided that this flat-surface state is acquired.
[0049] And it is SiO2 with this bad metal plug 26, for example, Cu and adhesion, in this state. The insulating layers 51, such as a film, and the metal layer 33, for example, W layers, which forms the 2nd wiring on this further are continuously formed one by one by elevated-temperature sputtering. Then, about an insulator layer 22, this compares with the coefficient of thermal expansion being small, and hardly contracting by the temperature fall from this state, and as when this contracts shows a metal plug to drawing 10 B, Gap g is formed between the metal layer 32 and a metal plug.
[0050] And to the metal layer 33, by the photolithography, predetermined patternizing is performed and the wiring 24 of the 2nd of a necessary pattern is formed. and a this top -- the need -- responding -- SiO2 etc. -- covering formation of the surface-protection film 27 is carried out
[0051] If it does in this way, the temperature sensor 30 in which the same gap g exists with drawing 1 having explained can be constituted.
[0052] Therefore, according to this temperature sensor 30, similarly, it can compare with an insulator layer 22 by the temperature rise, and when the metal plug 6 expands thermally greatly, Gap g can detect this as the increase in a tunnel current, and increase of electrostatic capacity by smallness and the bird clapper.
[0053] Therefore, detection of this tunnel current or electrostatic capacity can perform a thermometry conversely by measuring the relation between temperature and a tunnel current, or the relation between temperature and electrostatic capacity beforehand.
[0054] moreover, the detection as this electrostatic capacity -- as an insulator layer -- SiO2 etc. -- when using and using AlSi as a metal plug 26, the metal plug of the coefficient of thermal expansion is 40 times the insulator layer, and since electrostatic-capacity change can be measured as change per [400] degree C, it can perform temperature detection with high enough sensitivity
[0055] Moreover, according to this invention mentioned above, although it can measure about the heating temperature to a temperature rise from ordinary temperature, measurement to cooling temperature can also be performed. In this case, the thermometry to cooling temperature can also be performed by detecting change of the electrostatic capacity by increase of the gap length accompanying a metal plug contracting more by the temperature reduction, as it sets, for example, the gap length of Gap g is set to 0 in ordinary temperature, or change of a tunnel current.
[0056]
[Effect of the Invention] Drill the 1st and 2nd wiring 23 and 24 in an insulator layer 22 through an insulator layer 22, and it is made to counter through a bore 25 in this invention, as mentioned above. The metal plug 26 electrically connected with one wiring 23 of the 1st is formed in the bore 25 of an insulator layer 22. By change of electrostatic capacity or a tunnel current, since the temperature was detected, as for the temperature detection, it can perform with a high precision that the gap g between this and the 2nd wiring 24 changes with temperature changes.
[0057] Moreover, this temperature sensor can measure the temperature distribution covering the whole region of a wafer correctly from the ability of many temperature sensors 30 to be simultaneously fixed with high density to the common monitor substrate 21, since the composition fixed in the substrate 21 for monitors can be taken.

[Translation done.]